Studies on Human Variation In Indonesia*

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THE Honorable President of the Senate of Gadjah Mada University;
Honorable professors, Deans of Faculties and Directors of Institutes;
Distinguished colleagues, friends and relatives, and ladies and gentlemen.

The thoughts and opinions I want to express today are products of influences of many people upon me. It is therefore appropriate that on the occasion of my inauguration for the chair of an-

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thropology at the Gadjah Mada University Faculty of Medicine I express my gratitude to them.

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On this opportunity I will talk about human variation in Indonesia. Man is one of the successful organisms in the Pleistocene and Holocene

epochs. As a polytypic and polymorphic species, man shows a considerably wide variation. In Indonesia, which comprises thousands of islands with different environments and which has experienced a remarkable geological history by repetitively acting as a landbridge between Asia on one hand and the Pacific and Australia on the other, human variation is, not surprisingly, wide-ranging.

Variation among men is observed between age groups in a family, between local populations and between races. Differences are noted between modern man and ancient and early man. The variation in time is clearly noticeable if we follow the evolution of man since three million years ago.

Variation is the theme of nature. Mutation is the primary source of variation. Sexual reproduction with segregation and recombination increases the number of possible genotypes. Different and changing habitats, interacting with the genotypes, create multivarious phenotypes. If we assume that each individual has but 40,000 genes and that man has inhabited all kinds of habitats on earth with their subvariations, it is not surprising that there are no two identical individuals alive. Every man is "unique, unprecedented and non-recurrent."[1]

PLEISTOCENE MAN

In Indonesia, early man had been present for two million years.[2] His types belong to the genus *Pithecanthropus* which differs from modern man, *Homo sapiens*, especially regarding the brain. The lower limbs might not differ significantly[3] except for the robusticity of the limb bones with well developed muscles in early man. According to Dubois[4] the femur of *P. erectus*, who lived about 800,000 years ago,[5] displays a slightly different structure than that of modern man: the vasti and popliteus muscles are larger; the posterior aspect of the neck is flat; there is a lateral supracondyloid process; and the histological structure of the bone is distinctive.

From two million to 800,000 years ago, changes have not been conspicuous. *P. modjokertensis* of the early Pleistocene is distinguished from *P. erectus* of the middle Pleistocene mainly because of the time factor, thus as a chronospecies. Nevertheless, there was also variation in early Pleistocene man in Indonesia with the synchronic presence of the so-called *Meganthropus palaeojavani-*

cus. Its mandible is more massive, particularly the base, and its cheek teeth are much larger; these reflect its more herbivorous habit. Other mandibles also show variation, especially the so-called *P. dubius.* Its oblique line is steep and continues onto the base, likewise its masseteric fossa. It is interesting that both their premolars have two roots, a mesial and a distal one.[6]

Variation in age is evident when we compare the child of *P. modjokertensis* from Kepuhklagen, Mojokerto, who is six years old, and the adult from Bukuran, Sangiran. The supraorbital torus is not pronounced at six years and the thickness of the vault bones is still increasing. On the other hand, the mastoid process has appeared and the mandibular fossa is evident.

The cardinal difference between *Pithecanthropus* and *Homo* is the less developed cerebral cortex of the former. Consequently, the maximum breadth of the skull is located near the base, even if we exclude the supramastoid crest in the measurement, where euryon is sometimes located. Another consequence is the presence of parasagittal depression or flatness. The less developed frontal lobe causes the receding forehead and the protrusion of the supraorbital torus for the protection of the eyes. The torus continues laterally and posteroinferiorly, and bounds the postorbital constriction.[7,8]

Another distinct characteristic is the foramen magnum which is more posteriorly situated so that strong neck muscles are needed for maintaining the head balance. Consequently, the nuchal plane is relatively larger than the low occipital plane; both are separated by the occipital torus where the occipital bone angulates. The cerebellum is relatively small so that the internal occipital protuberance is lowly located. Because the external occipital protuberance is located more highly, the two protuberances are not at the same level. The external occipital crest is absent or only slightly discernible.[9,10]

On the side of the skull a complex of characteristic traits of *Pithecanthropus* are present. At the level of the parietal boss, the parietal bone angulates strongly. The temporal squama is very low and its shape is more or less triangular. All of these are brought about by the lesser development of the brain. Another important trait is the strong supramastoid crest which contributes in the formation of the tegmen pori acustici.

On the cranial base we also find traits that distinguish *Pithecanthropus* from *Homo.* The basilar portion of the occipital bone is wide and not bounded by a clear petrooccipital fissure from the petromastoid portion of the temporal bone. The foramen lacerum is absent. And the petrotympanic axis forms an angle.

On the cerebral aspect, we observe the characteristic ramification of the middle meningeal grooves, i.e. the posterior branch is larger than or as large as the anterior branch. At the stem we usually find a meningeal canal.[11] Furthermore, in *Pithecanthropus* the vault bones are always thick.

We do not have many remains of the face of *Pithecanthropus.* We know that the nose root is broad and the nasion notch is present. The anterior crest at the base of the piriform aperture is not well marked. The lacrimal fossa is absent.

The teeth of *Pithecanthropus* are large; the posterior molars have not reduced significantly except the last upper molar. The root systems are still primitive in some specimens, such as the two-rooted lower premolars mentioned above. The upper first premolar in *P. modjokertensis* has three roots.[12] The sequence of bony eruption might be slightly different from the usual pattern in *Homo sapiens.* The frontal process of the zygomatic bone is thick in order to fit the massive zygomatic process of the frontal bone.

The mandible has no chin and its oblique line and lateral torus are prominent. The large teeth cause the massive alveolar process and the low location of the mental foramen.

Whether *Pithecanthropus* has 46 chromosomes as *H. sapiens,* 48 as *Gorilla* or 44 as the gibbon, we do not know. We note that gibbons and siamangs, which are similar in morphology, have different numbers of chromosomes (50 in siamang).[13] By immunological approach, it is found that between the gorilla and chimpanzee, which have a similar morphology and the same chromosome number and are classified into two genera, there is an index of dissimilarity or immunological distance of 1.17. This is larger than the ID between the gibbon and siamang, which is 1.07.[14] Therefore, I think it is appropriate if *Pithecanthropus* is classified in a separate genus. The difference in brain development reflects differences in many genes. The conspicuous difference in the development of the cortex also reflects the difference in skill which further indicates the dif-

ference in ecological niche. The difference in the way of exploiting the environment signifies that the evolution from *Pithecanthropus* to *Homo* is not just a case of speciation, but macroevolution. In regard to the differences in the infracranial bones of *Pithecanthropus* and *Homo* we are not very certain, since the femora of *P. erectus* are dissimilar to those of *Pithecanthropus* from Peking or Olduvai.[3] But even if these differences are not considerable, it is not surprising, because supra-organic evolution in man makes the physical difference less and less prominent. The most important feature in hominid evolution throughout the Pleistocene is the evolution of the brain.

In the Middle and Upper Pleistocene, an important variation existed in the taxon *Pithecanthropus*. At that time we have *P. soloensis* beside *P. erectus* in Indonesia. The former has a larger brain and probably also a greater body size. His cranial capacity is between 1000-1300 cc, while in *P. erectus* it is only 800-1000 cc. This discrepancy is not due to intraspecific sexual dimorphism or ontogenetic difference. Differences in sex and age can be observed both in *P. erectus* or *P. soloensis* finds.

Owing to the larger size of his cerebral cortex, the parasagittal area in *P. soloensis* is flat, not concave. His postorbital constriction decreases, his infratemporal fossa begins to be filled and his cranial height increases. In the occipital area a triangular prominence is found at inion. There is a slight external occipital crest, especially near the foramen magnum.

On the cranial base, the foramen magnum is angulated in two planes corresponding to the nuchal plane and the plane of the subcerebral portion of the skull base. The distance between the entinion and ectinion is less compared to that in *P. erectus,* reflecting the development of the cerebellum. It is important to note that the oval foramen is located within a fossa with another foramen. This accessory oval foramen is probably for the accessory meningeal artery.[15] The canalis musculotubarius is very large in *P. soloensis.*

In front, the supraorbital torus begins to undergo a disintegration, particularly in the glabellar region. The cheekbone is massive with a thick inferior border.[5]

It is difficult to know if there was reproductive isolation between *P. erectus* and *P. soloensis.* They did coexist for a period of time, but *P. soloensis*

survived up to the late Pleistocene. In the living primates there are also cases of coexisting species, i.e. synchronic and sympatric species.

At the end of the late Pleistocene, *H. sapiens* already existed in Indonesia and adjacent areas. These human populations, whose remains were found at Wajak (Tulungagung, East Java), Niah (Sarawak, North Borneo) and Tabon (Palawan, the Philippines), demonstrate some interesting features. Wajak has a wide flat face, while his skull is dolichocranic, resulting in a dysharmonic head. The nose is wide and low. There is alveolar prognathism, but no canine fossa is present.[16]

On the skull, a sagittal torus is evident with flattening at lambda. On the cranial base there is a precondylar tubercle. And the condylar index is low in Wajak man.

Interesting are the relatively large teeth as compared to those in the living populations. Consequently, the mandible is also large and has a broad ramus. In the upper molars, we encounter a hypoconule as the fifth cusp.

Some variations are exhibited by Niah man. His nasion is deep below which there is a broad nasal aperture with a sharp inferior border. The teeth are not as large as in Wajak.

At the time of Wajak and Niah men, human variation in South East Asia seems not to have been as great as at present. This appears to be the situation from 40,000 to 15,000 years ago. Racial elements were not as mixed as today and the area inhabited was also not as wide.

POST-PLEISTOCENE MAN

In post-Pleistocene times we observe trends toward the present condition. Racial elements began to appear. It can be stated roughly that in the west and north of Indonesia we have Mongoloid elements, but Austromelanesoid elements were still present. This is proven by human skeletal finds of the Epipaleolithic Age. The skeleton from a shell mound at Alur Itam, Tamiang (East Acheh, North Sumatra) for example, which was found in 1965 associated with some Hoabinhian tools and mammalian fossils, shows Austromelanesoid features. The dolichocranic skull has a wide nasal root. The mandible is not robust as is usually the case in the present Melanesians. Likewise, the dental measurements are smaller than in these people. The skeleton of this 40-year old woman has a stature of 153 cm.

Another skeleton, found in the kitchen midden at Binjai, Tamiang, in 1929, also has a short stature and a dolichocranic skull.[16] I think that the populations of the middens of Tamiang and East Sumatra are not dissimilar to the population of the Gua Kepah middens on the Malayan Peninsula across the Strait of Malacca.

The caves of East Java, especially Sampung, revealed similar populations as well. The skulls are dolichocranic and have a sagittal torus and constriction in the temporal area. The side walls of the skull are almost vertical and in the occipital area a "cignon" is present. The cheekbones do not demonstrate Mongoloid features. The jaws and teeth also remind us of the Austromelanesoid race, and similarly the pelvic bones.[17]

Other skeletons from the caves of East Java, such as the Petpuruh, Sodong and Marjan caves and the one in Bojonegoro, display Austromelanesoid characteristics, too.[18] Thus, it can be concluded that the populations of Tamiang and East Java in the Epipaleolithic Age did not differ very much except for the admixture of some Mongoloid elements in the northwestern part of Indonesia.

Other Epipaleolithic remains came from the Toalan cave culture of South Celebes. Two skeletons from Uleleba cave have short stature[19] (Sarasin, 1903). The skeletons from Bola Batu and Leang Karassa are not distinguishable from those of the living Buginese.[20] A study of 2682 permanent teeth from Leang Chadang, Soppeng, shows the predominance of Mongoloid elements. The incisors and canines, for example, have a high frequency of shoveling. Labidodont occlusion or edge-to-edge bite is still commonly found. Premolar cones and talonids on the second lower premolars, characteristic for Mongoloids, are also often encountered.[17]

Beside the racial variations brought about by migration or hybridization, there is also variation due to local microevolution. Various primitive features, for example, are found on the teeth from Leang Chadang, such as the sixth and seventh tubercles. The upper molars are still relatively large.

Other Epipaleolithic human remains were discovered in the caves of Flores. Here the Austromelanesoid elements are stronger too. The skull is long and oval in vertical view and gable-shaped in occipital view. The mandible is massive and the dental dimensions are comparable to those of Sampung and Gua Kepah, but the molar crown patterns resemble that of Leang Chadang. These indicate the predominance of Austromelanesoid element which had undergone further microevolution than the population of Sampung.

To summarize, it is evident that in the Epipaleolithic Age in northwest Indonesia the Austromelanesoid element was still strong, but had already hybridized with some Mongoloid elements. In the southern part of West Indonesia, Mongoloid elements were not evident. Farther to the east the situation was still the same as before, in fact it continues until recent times. On the contrary, in the northern part of East Indonesia Mongoloid elements were much stronger, indicating a line of affinity between East Asia, the Philippines and Celebes.

Of the Neolithic Age we have no skeletal finds complete enough for a thorough study. If we turn to Malaysia, Thailand and Indo-China, we are aware that the Mongoloid elements were either as strong as the Austromelanesoid or already predominant.[21,22,23] In the Paleometallic Age the situation became clearer; it seems that there was polarization of racial elements: in the west and north of Indonesia the Mongoloid element was stronger or was the only racial element, whereas in the east and south the Austromelanesoid element was stronger or was the only element. Such situation has been more or less perpetuated up to the present.

The skeletal evidences for this are the skeletons from Anyer Lor (West Java), Puger (East Java), Gilimanuk (Bali), Melolo (Sumba) and Lomblen. Austromelanesoid and Mongoloid features appear to be mixed in the remains from Anyer Lor, Puger, Melolo and Lomblen, while in the Gilimanuk the Mongoloid features are stronger.[17,24-27] Several finds from other sites support this rough classification, e.g. the skeletons from Buni (West Java), Sangiran (Central Java), South Celebes, Flores, etc.

Viewed racially, the present situation is a continuation of the trend mentioned above with farther shift of the Mongoloid distribution toward the east, several backflows to the west, with principal admixture in the area in between, the Wallacea. Besides, Mongoloid elements from the north are still continuing to flow, slowly and steadily, toward the south.

Variations in the present Indonesian population can be investigated more thoroughly, because we can study the living beside the skeletons and teeth. The variation is tremendous indeed, affecting monogenic as well as polygenic traits, and morphological, physiological, serological as well as biochemical characteristics.

HEIGHT AND WEIGHT

Stature has a wide variation in the present Indonesia, i.e. between 135-180 cm, in other words from short to tall. The mean stature is probably slightly different between several local populations, but in many cases the differences are not significant. In the cities stature seems to have increased in the last decades, e.g. in Jakarta,[28,29] but in the rural areas the increase is non-existent or very small, e.g. in Gunungkidul between 1941[30] and 1971.

Body weight varies between 30-75 kg with concentration in the 45-55 kg bracket; in the mountain areas and cities, body weight is slightly greater. Body weight is more influenced by environment than body height. The increase of body weight in the rural areas in the last 30 years is also not remarkable.

Birth weight is also low in Indonesia. In Yogyakarta for example, the mean birth weight is 2.89 kg, similar to the condition in East Timor. Infants of well-to-do groups in Yogyakarta have a mean birth weight of 3.02 kg, resembling the condition in Malaysia. In Gunungkidul the mean birth weight is 2.72 kg as is the case in India.[31] Birth weight is not only influenced by environment, but also by genetics.

The relationship between body height and weight is difficult to express in simple formulas, like those of Broca, Beckert, Habs, Ott, etc.[32] In assessing leanness-fatness ratio it is better to also consider other criteria, such as chest breadth or shoulder breadth and skinfold thickness.

BODY BUILD

The total skinfold thickness, i.e. the sum of the deltoid, infrascapular and suprailiac skinfold thickness, is, according to our investigation in Rongkop (Gunungkidul) and Kejajar (Wonosobo), on the average 25 mm in women and 16 mm in men. In Mongoloids, the skinfold thickness is not high; this might also be a part of adaptation to the tropical climate. The problem

of obesity is not a crucial problem in Indonesia. If skinfold thickness is correlated with body height and weight, we have the lean score.[33] Among the peasants of Rongkop and Kejajar, the lean score in general is above 4, which means lean or thin, particularly in males.

Body build is also influenced by fatness or leanness. In a somatotype study in both the above-mentioned areas, utilizing the Heath-Carter method,[34] the most frequent somatotype turns out to be mesomorphy, either in males or females; endomorphy is very rare. This condition is mainly the result of their occupation as peasants beside the nutritional environment. Among the Indonesian Air Force Academy recruits of 1970 from all regions of Indonesia who were somatotyped anthropometrically (modified Sheldon method), ectomorphy is most often found, whereas mesomorphy occupies the second place. Endomorphy is more frequent than in either of the above places. This might be due to the different methods used and the different composition of the populations of which the recruits constitute a selected sample which had gone through various physical and medical tests.

The ratio between the pelvic and acromial breadth influences body build as well. Similar to the condition in other Mongoloids, this ratio in Gunungkidul and Wonosobo is below 73. This figure is lower relative to the Caucasoid race. In the males, the index is lower than 68.5; in this case the difference between males and females is not remarkable. In addition to the smaller size of the pelvis, suprailiac fat deposition in females (the biiliac diameter was measured on the skin without pressure) in our populations is not so great.

SKIN VARIATIONS

Skin color variation among Indonesians is not wide. In our investigations of Yogyakartanese chest skin color belongs chiefly to color group 12-15 of the von Luschan scale which comprises nuances of brown. In West Indonesia truly black skin color does not exist; the darkest color is blackbrown. Beside genetics, skin color is influenced by environment and might be an adaptation to climate. It is also possible that skin color differences exist between social strata, because of the reluctance to work or play in the sun among the upper class, and the differences are inherited

to the next generation through mating preference in which those with lighter skin color are favored.[35]

Chest skin color in babies of 3-10 days old in Yogyakarta is concentrated in two color groups, i.e. 22-24 and 15-17 according to the von Luschan scale. By using the reflectance spectrophotometer and filter No. 605, wave length of 550 $m\mu$, the reflectance in the scapular region in Yogyakarta infants, aged between eight days and $4\frac{1}{2}$ years, is found to be 12-29%. Sacral or mongoloid spots are present in 95% of babies in Yogyakarta in conformation to its distribution in the Mongoloid race. Similar frequencies are found among Chinese, Japanese, Koreans and Indo-Chinese.[36]

Pilosity is not remarkable in Indonesians; because the Mongoloid element is predominant, body hair is scanty. Baldness is rare, although calvities on the forehead are quite common in males; its frequency in Yogyakarta is 71.7%.[37]

Of the skin, dermatoglyphs of the finger and palm are also important. As Mongoloids, the frequency of arches is very low, in general below 3%. Only in the investigation in Klaten, a higher percentage of arches is found, namely 5.19% in females and 4% in males and females. This is interesting and requires further study. In other Mongoloids there are also reports about rather high frequencies of arches, such as in Annam.[38] The Dankmeijer index in Java varies between 5 and 10. The total finger ridge count ever been studied is among the population of Kejajar, resulting in 12.3 ridge per finger in the female and 14.4 in the male. The main line formula on the palm in Yogyakarta is chiefly 7.5″.5′ and 9.7.5″, indicating that the direction of the ridges is not really transverse. In the Mongoloid race main line D mostly ends in areas 7 and 9.

BLOOD GROUPS

In regard to the blood groups, most studies in Indonesia concern the oldest known ABO system. In Yogyakarta blood group O is the most common, with a gene frequency of 0.61, while the frequency of gene B is 0.23. These frequencies are similar to those among the people of Acheh, Deli, Batak and Minangkabau.[39,40] In a group of Achehnese in Yogyakarta the frequency of gene O is 0.63 and the frequency of gene B 0.20. In East Indonesia the frequency of gene O rises from 0.65 in Timor[41] to 0.81 in Ceram, whereas the

frequency of gene B decreases from 0.13 in Ambon to 0.10 in New Guinea. If Timor does not show any difference with West Indonesia, in Nias the frequency of gene O is very high, while the frequency of gene A is very low. The population of Kurinchi (West Sumatra) reveals some deviation, because their frequency of gene O is low (0.50), whereas that of gene B is high (0.28). It is known that monogenic traits, such as the ABO system is easily influenced by genetic drift, especially in this country which consists of thousands of small islands where people have lived in small groups. It should be noted that subgroup A_2 is not found or is very rare in Indonesia.

Of the MN system the frequencies of genes M and N are about equal. In Yogyakarta we found the frequency of gene M to be 0.54 and of gene N 0.46. In the north, e.g. Thailand, the frequency of M is higher, while in the east, e.g. New Guinea, the frequency of N is very high.

Of the Rh system the most common gene we found in Yogyakarta is CDe (R_1), the most frequently occurring gene in East Asia and Australia, which is 82.5%. cDe (R_0) and cDE (R_2) are also found but in small frequency. It is interesting that the rare gene CDE (R_z) is also present. The most common genotype is CDe/CDe (R_1R_1). d is totally absent, so that no Rh negative individual is encountered.

Furthermore, in Indonesia the following blood groups are also found: Lewis (Le(a+) 40% in Java, Kidd (Jk(a+) 100% in various Dayak tribes), Diego (also in various Dayak tribes), Lutheran (0.01 among the Dayaks) and Duffy (Fy(a+) 0.8).

ABNORMAL HEMOGLOBINS

Abnormal hemoglobins were also reported from Indonesia, such as Hb C, Hb D, Hb E and Hb F in adults (or Hb A_2). In the case of thalassemia it is postulated that its gene frequency is maintained by balanced polymorphism which favors the heterozygotes (thus, sufferers of thalassemia minor) which are thought to be resistent against malaria. Hb S is not found in Yogyakarta.

ENZYME DEFICIENCIES

Several enzyme deficiencies or variants have been reported as well from Indonesia, such as the glucose-6-phosphate-dehydrogenase.[42] Besides, the

high incidence of milk intolerance causing alimentary complaints indicates the presence of lactase deficiency.[43] In Yogyakarta, the incidence is around 20%; in Thailand the figure is much higher, in fact, it reaches 100% in several populations. This condition is assumed to be due to cultural selection: the deficiency of lactase or β-galactosidase, either primary or secondary, has a higher incidence in the population which is not acquainted or is just recently acquainted with dairy animals or milk utilization.[44]

OTHER TRAITS

Taste blindness for phenyl-thio-carbamide has a gene frequency between 0.30-0.40 in West Indonesia;[45] in the Tengger mountain area its frequency reaches 0.50, while in Bali and Lombok it is only between 0.05-0.10.[38]

Cerumen or ear wax is of two types, the wet (in Japan called *nekomimi*) and the dry type (*nukamimi*). The wet gene is regarded as dominant and is inherited in a simple Mendelian manner.[46] In the Mongoloids the wet gene is less frequently found than in other races. Our investigations in Gunungkidul and Wonosobo show that the dry gene is more frequent, i.e. 0.72 in the former and 0.63 in the latter place. Those frequencies are similar to the findings in the aboriginal populations of Formosa and Micronesia. In the dry cerumen lysozym and immunoglobulin IgG are more abundant.[47]

Free ear lobes are postulated by some to be inherited as a simple dominant factor. In Gunungkidul the frequency of free ear lobes is 33%, whereas in Wonosobo 44%. In the neonates in Yogyakarta the frequency of free ear lobes is higher, approaching 70-80%. In the adults of Yogyakarta the frequency is between 64-68%. In the Malay aboriginals of Malaysia (*Orang Laut* and *Orang Darat*), the frequency is around 57%.[48]

The total active sweat glands in the Sasaks of Lombok is about 130 per cm² in the lower arm and infrascapular region, 118 per cm² on the chest, 100 per cm² in the medial femoral region and 160 per cm² in the lateral femoral region.[49] In the Japanese the figure is smaller, and likewise in the Caucasoid race; it is probably due to their larger body size, while the total sweat glands do not differ significantly.[50]

The blood pressure shows a discrepancy be-

tween rural and urban areas, and between agricultural and industrial countries. The condition is influenced by nutrition and mental stress in city life. Among the peasants of Gunungkidul and Wonosobo we found that the mean systolic pressure is between 113-119 and the mean diastolic pressure between 63-66.

BIRTH, GROWTH AND DEATH

In rural areas the number of children is expected to be high compared to that in hunting or shifting agricultural communities, particularly if the health status in the first mentioned areas is higher, because of the decreasing infant mortality rate. In Rongkop the number of children among women between 18-60 years old is most frequently between three and five (30%), while in Kejajar it is higher than five (40%). The average figure is 3.2 for Rongkop and 4.5 for Kejajar.

Dizygotic twin birth in Central Flores is 8.8%, whereas monozygotic twin birth is 4.9%.[51] The frequency of monozygosity does not differ much from that in other races, but the frequency of dizygosity is similar to that in the Caucasoids, therefore lower than in the Negroids, but higher than in the Japanese.[50]

Age of puberty can be determined by menarche in the female and by spermarche in the male. In our investigation, using the recollective method, in Yogyakarta the mean age at menarche turns out to be 14.5 years.[52] This resembles the condition in Klaten, but differs from that in Semarang (13 years) and Jakarta (12.5 years) or Surabaya (13.5 years).[53] The age at menarche in Singapore is between 12.5-13 years.[54] As we know menarche is influenced by genetic as well as environmental factors.

Spermarche or the first seminal pollution is more difficult to establish by using the recollective method than menarche. In our study in Yogyakarta the age at spermarche is on the average 15.3 years. In Budapest, spermarche occurs between 13-16 years.[32]

The expectation of life at birth in Indonesia is estimated to be between 40-50 years. In the lower socioeconomic bracket which is still untouched by medical care, the age at death is of course lower and the infant mortality higher. If we investigate the age at death of cadavers in our Laboratory of Anatomy which are derived from the provinces of Central Java and Yogyakarta, from Purwokerto in

the west to Surakarta in the east and from Kudus in the north to Wonosari in the south, we get a picture of attainable life span in the marginal economic bracket. The peak of mortality is found to be between 21-30 years for males as well as females. Therefore, only a small portion of human life span was lived by this group.[11] The age at death is lower than that of the cadavers in American anatomy laboratories of the past, before individuals of higher economic brackets will their bodies to medical schools (37 years for Negroes and 45 years for Caucasoids).[55]

TEETH

As regards the dentition we expect the Indonesian would follow the dental master pattern of the Mongoloids or the Austromelanesoids or both. In a study of the present Sangiran population we found 87.6% psalidodont occlusion or scissor bite. The upper dental arch is mainly oval or parabolic in shape, while the lower dental arch is mainly parabolic or hyperbolic. Dental crowding occurs chiefly in the anterior dentition, and particularly the second incisor. This tooth is in the upper jaw usually lingually displaced (in-standing) in the Mongoloid race. At 18 years of age around 34% of the third molars are still unerupted, whereas at 30 years 30%. The incidence of agenesis of the third molar is high in several Mongoloid groups.

Thus, we have a bird's eye view of human variation in Indonesia in time and space. In time we have observed the macroevolution from *Pithecanthropus* to *Homo* with cardinal changes in the brain and its case, the neurocranium, especially the increase of the cranial capacity from 800 to 1400 cc, and the reduction of the most upper portion of the alimentary canal, the viscerocranium, especially the reduction of the masticatory muscles, jaws and teeth. At the end of the Upper Pleistocene and the beginning of the Holocene microevolution in the genus *Homo* began to take place, locally or by gene flow. Genetic drift is assumed to play an important role in this archipelago, particularly among the Paleolithic and Epipaleolithic people who lived as hunters and gatherers in small groups.

The population is estimated to be low in the Lower Pleistocene and the area inhabited might be restricted to the Sundaland. If subsequently East Indonesia was populated, migration must have taken place through the Philippines. It was

in the Neolithic Age that the population started to increase, the area inhabited became more extensive and human variation became wider. Never was the population evenly distributed throughout Indonesia. Even now 50% of the world population live in 5% of land area.[50]

It is possible that man and his variation in the Neolithic did not differ much from the present population, except for the process of gracilization which had proceeded further and the dental reduction (in number, size and crown pattern) which became more advanced. During this age brachycephalization is thought to become widespread in Indonesia, especially in the west and north. It should be kept in mind that the processes of evolution do not proceed at the same rate for all body parts, so that mosaic evolution is encountered. There are body parts which are already progressive existing side by side with parts still primitive or archeic. Mosaic evolution is also found in cultural evolution.

The present human variation has a wide range and reflects the interaction between genetics and ecology. Every individual has between 10.000 and 100.000 genes; at many loci multiple alleles occur. And many of the physical traits are polygenic. Moreover, one gene can be influenced by modifying genes and gene environment. The penetrance of a gene may differ in different environment. Just as the natural environment, uterine or prenatal environment also influences the individual. And we are aware of how variable the human environment is from place to place and from time to time.

Therefore, existing differences between various local populations in Indonesia are not always due to racial factors; many of them are products of adaptation, isolation and genetic drift. In the future we expect that differences between these populations will decrease owing to the unifying process which will make the whole population in this country consists only of several or one gene pool.

From the above discussion on human variation it is evident the various lines of research which can be taken, each having its particular ends. There are still many gaps in our knowledge on man in Indonesia, either the gaps in time since human remains of several periods have never been or are only scantily recovered, or the gaps in space since many populations have never been or are

barely investigated. To make an inventory of human variations in Indonesia, to analyze their causes and to synthesize them is a gigantic task, which shrinks every investigator facing it. For this very task, with my strength and weakness, I humbly offer my efforts and laboratory.

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